THE FUNCTION OF THERMOREGULATION IN PROTRACTED LIMITATION OF MOTOR ACTIVITY (HYPOKINESIA)

A. Ya. Tizul

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16. Abstract

On the basis of study of thermotopography at 10 symmetrical points and the Shcherbak thermoregulation reflex in 10 normal individuals subjected to prolonged (120-day) clinostatic hypokinesia the author demonstrates that thermoregulation function disturbances develop along with other hypokinetic disorders so early as the beginning of the 2nd month. Subjective temperature discomfort is accompanied by changes in the zonal interrelation of skin thermotopography, torpidity (hypo-reactivity), or reversal of thermoregulation mechanisms in response to application of local thermal loads (45° Gauffe hand bath for 30 minutes). Thermoregulation function disturbances increased with advancing hypokinesia. Thermoregulation is restored about a month after transfer of the subject to a normal motor regime.

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THE FUNCTION OF THERMOREGULATION IN PROTRACTED LIMITATION OF MOTOR ACTIVITY (HYPOKINESIA)

A. Ya. Tizul'

The present project was conducted with the aim of studying the influence /1791* of protracted (120-day) clinostatic hypokinesia on the thermoregulation function.

The thermoregulation function was studied in 10 healthy males ranging in age from 23 to 44 years. The subjects, divided into 3 groups, were in ordinary beds in hospital wards. They were permitted only limited rotation around the vertical axis of the body. Ingestion of food and hygienic procedures were accomplished with the subjects in the horizontal position.

In the first group (4 persons), which we have termed the control group, the state of thermoregulation was studied with hypokinesia in the "pure" form. In the two other, experimental, groups (each consisting of 3 persons) the thermoregulation function and the phenomenology of hypokinetic disorders were studied against the background of the taking of certain pharmacological substances (pituitrin, and then DOKSA in the second group and nerobola in the 3rd) in accordance with a definite schedule. The experiment was conducted during the warm season of the year (May-August).

The thermoregulation function and adaptive thermoregulation mechanisms were evaluated on the basis of measurement of the temperature in the axillary region, the cutaneous thermotopography at 10 symmetrical points of the body (forehead, cheek, neck, chest, shoulder, back of the hand, abdomen, hip, shin, and top of the foot), and the dynamics of the Shcherbak thermoregulation reflex. Recording of the temperature parameters (Shcherbak's thermotopometry and reflex) was performed once every 15 days under identical basal metabolism conditions, always in the morning (at 7 o'clock) with a comfortable ambient air temperature (22-24°) and comparatively slight relative humidity fluctuations (55-70%). The customary taking of temperature with a maximum medical thermometer on the left

*Numbers in the margin indicate pagination in the foreign text.

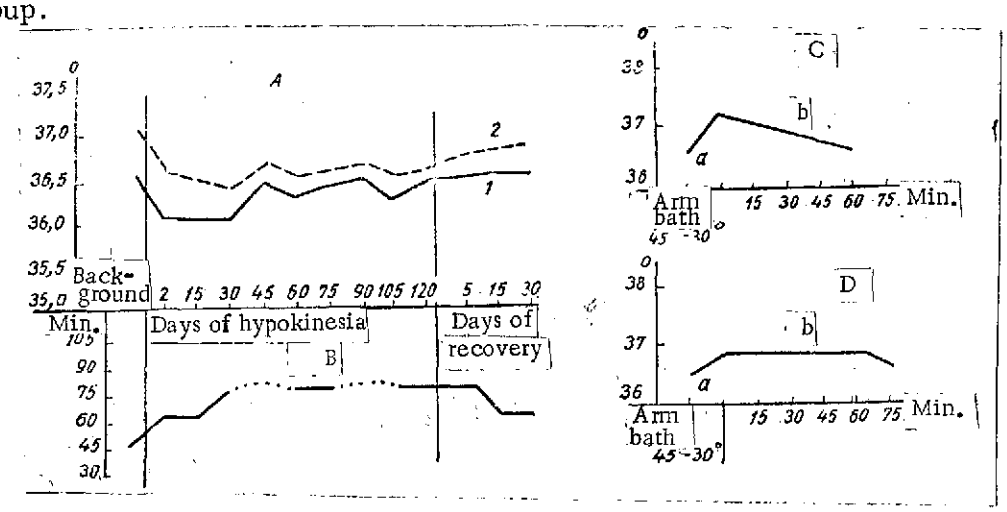
and right was carried out daily. The thermotopometry was always carried out before investigation of the Shcherbak reflex. Data of analysis of the subjective states of the subjects were also taken into account in evaluation of the thermo- /1792
regulation function. Complaints of a periodic sensation of temperature discomfort were made by all the subjects, the most often by the 3 persons in the control group and by 1 person in the second group. The condition of temperature discomfort was given the same evaluation by the subjects. Despite the fact that the air temperature in the wards equaled 22-24°, the subjects complained of being chilled and of a feeling of coldness in the distal parts of the extremities, especially the legs. They often stated that they could not get warm. One of the subjects wore wool stockings at all times because of a constant sensation of cold in his legs.

The subjective sensations of temperature discomfort appeared at the beginning of the second month of the experiment and were accompanied by objective changes in skin temperature. Thus change in the parameters of cutaneous thermotopography, which reflect the state of the temperature of the "shell," and the dynamics of the Shcherbak regulation reflex, which chiefly reflects the state of the temperature of the "nucleus" [15], was noted even on the 30th day of the experiment.

The drawing illustrates certain parameters of the thermoregulation dynamics of 1 subject of the first group. As may be seen from the drawing (lower curve — B), even on the 30th day of the experiment after application of the local standard thermal load (Gauffe arm bath of a temperature of 45° for 30 minutes) increased in the time of restoration of the rectal temperature to 75 minutes was observed (rather than the normal 45-60 minutes), and on the 45th and 90th days of the experiment the rectal temperature failed to reach the initial value. Up to the end of the experiment and during the first two weeks of the restoration period torpidity of the thermoregulation processes was observed, being indicated by hyporeactivity or absence of reactivity of the thermoregulation mechanisms in response to application of local thermal load, as well as by increase in the restoration time of the rectal temperature to the initial level. The disturbances of the thermoregulation dynamics became more pronounced on the 45th day; the thermal test caused virtually no reaction on the

part of the thermoregulation system. Graph B of the drawing which illustrates the dynamics of the Shcherbak reflex on the 75th day of the experiment, unlike graph C (2nd day of experiment), exhibits a flat thermoregulation curve indicating hyporeactivity of the thermoregulation mechanisms. We observed /1793 approximately the same picture of thermoregulation dynamics (Shcherbak reflex) in the majority of the subjects, although it should be noted that these changes were somewhat less pronounced in the subject of the 3rd group.

Analysis of the data of study of the cutaneous thermotopography demonstrated that even at the beginning of the 2nd month of hypokinesia there was observed a clearcut tendency toward smoothing of the zonal differences in skin temperature and for narrowing of the range of numerical values between the oral-caudal and proximal-distal parts of the body, chiefly as a result of a certain elevation of the temperature in the distal parts of the extremities. These characteristics of the thermotopography with a certain increase in intensity were observed throughout the experiment and were more distinct in the subjects of the 1st and 2nd group.



Indices of Thermoregulation Dynamics of Subject P. in the Process of the Experiment. A, Characteristics of thermoregulation curve before (1) and after (2) application of thermal load according to Gauffe; B, time of restoration of rectal temperature to initial values (min); C, dynamics of Shcherbak thermoregulation reflex on second day of experiment; D, same on 75th day of experiment; a, rectal temperature before application of thermal load; b, after application of thermal load; x-axis, dynamics of restoration of rectal temperature; y-axis, temperature (degrees).

Restoration of the thermoregulation function occurred approximately toward the end of the 1st month after transfer of the subjects to an ordinary motion regime.

In recapitulation of the data of study of the majority of the temperature function indices it is to be noted that the most general feature of the thermoregulation dynamics during protracted hypokinesia is torpidity and hyporeactivity of the thermoregulation processes. In addition, in individual subjects the Shcherbak reflex indices indicated absence of reactivity for distortion of the thermoregulation mechanisms.

Thus definite disturbances of the thermoregulation functions developed during protracted clinostatic hypokinesia, ones which are paralleled by clinical and metabolotrophic disturbances, which have been described by a number of authors [2, 6, 12]. The administration of pituitrin and DOKSA in the 2nd group of subjects had no positive effect on thermoregulation, while in the persons of the 3rd group, who took narobol a favorable effect on the thermoregulation function was observed, along with decrease in the intensity of the other hypokinetic disorders [2, 14].

The disturbances of thermoregulation we observed at the beginning of their occurrence are in all probability an expression of modification of the general adaptation of the organism in response to restriction of motor activity. They may be considered to be an adaptive thermoregulation mechanism. The subsequent increase in disruption of thermoregulation was accompanied by intensification of the hypokinetic disorders (vegetative-vascular dysfunction, water-electrolyte, endocrine-metabolism, and other disturbances), this indicating the general nature of the pathogenic mechanisms underlying the development of hypokinetic disorders.

Variation in the excitability of the subcortical vegetative (thermoregulation) centers and functional dynamic displacements at the level of the hypothalamic formations performing regulation of a number of adaptive processes, including the thermoregulation processes, is apparently of considerable importance of the development of the thermoregulation disturbances described and a number of other vegetative disorders in hypokinesia. Depending on the neurodynamic conditions (excitation, inhibition, afferentation from the reflexogenic

zones), the thermoregulation centers excite inadequate and often opposite forms of activity. In addition, in the genesis of the disturbances observed a certain part is apparently played by dissociation between the contractive and non-contractive levels of thermogenesis occurring during protractive hypokinesia. The heat formation which under ordinary conditions if provided chiefly by the contractive activity of the muscles in all probability gives way as a result of the restriction of motor activity to non-contractive thermogenesis of the muscles and internal organs, and this in turn results in thermal imbalance and change in the mechanisms of thermoregulation adaptation.

Thus restriction of motor activity, which has long been applied as a therapeutic factor, when employed over a lengthy period of time causes a large number of polymorphous changes in various systems of the organism, including the thermoregulation system. This in all probability may have an effect on the /1794 nature and dynamics of the processes of restoration of health in the sick, and this must of course be taken into account by clinicians in prescribing protracted bedrest for patients.

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